


MOKELUMNE WATERSHED AVOIDED COST ANALYSIS:

Why Sierra Fuel Treatments Make Economic Sense

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FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

Appendix B: Insects, Diseases, and Abiotic Factors

B.1 Current Condition

The desired state of forest health, in relation to insects and diseases, is the condition in which these agents do not threaten ecosystem structure and function and/or management goals and objectives. Many of the forest types in the Mokelumne watershed are showing symptoms of forest health decline. In many areas, fire exclusion, grazing, logging activities, or no management, have combined with environmental and ecosystem changes to create overly dense stands, a loss of age diversity, and an altered mix of vegetation. This alteration of conditions has resulted in an increase in susceptibility to insects, pathogens and weather-induced stresses. Bark and engraver beetles, root diseases, mistletoes and an introduced fungus which causes white pine blister rust are important forest insects and diseases in the Mokelumne watershed.

Historically, the most significant widespread effect on vegetation has been conifer mortality associated with bark beetles and severe moisture stress. Conifer mortality tends to increase when annual precipitation is less than about 80% of normal (S. Smith, unpublished data). Trees stressed by inadequate moisture levels have their normal defense systems weakened to the point that they are highly susceptible to attack by bark, engraver and woodboring beetles. The bark and engraver beetles operating in the Mokelumne watershed are native and have coevolved with their host species. These beetles are fairly host specific which assists in determining the cause of tree mortality. Red and white fir mortality is associated with attacks by the fir engraver beetle (*Scolytus ventralis*). Mountain pine beetle (*Dendroctonus ponderosae*) attacks sugar pine, western white pine, whitebark pine, lodgepole and ponderosa pine. Western pine beetle (*Dendroctonus brevicomis*) attacks ponderosa pine and Jeffrey pine beetle (*Dendroctonus jeffreyi*) attacks Jeffrey pine.

Each of the past seven years, between 1,000 – 7,000+ acres in the Mokelumne watershed have had some level of tree mortality caused by bark and engraver beetles[1] (Table B.1 and Figure B.1). The highest number of acres with mortality has been attributed to fir engraver beetle, primarily in white fir, and mountain pine beetle in lodgepole pine. Effects resulting from bark beetle-caused tree mortality can include openings that vary in size, fewer trees/acre, reduced canopy closure, increase in standing dead and down woody material, increase in fuel load, increase in decomposition and nutrient cycling, increase/decrease in species diversity, and changes in forest structure and species composition. The importance or significance of these effects depends on their severity and extent, and ultimately how they affect ecosystem structure and function and specific management goals and objectives.

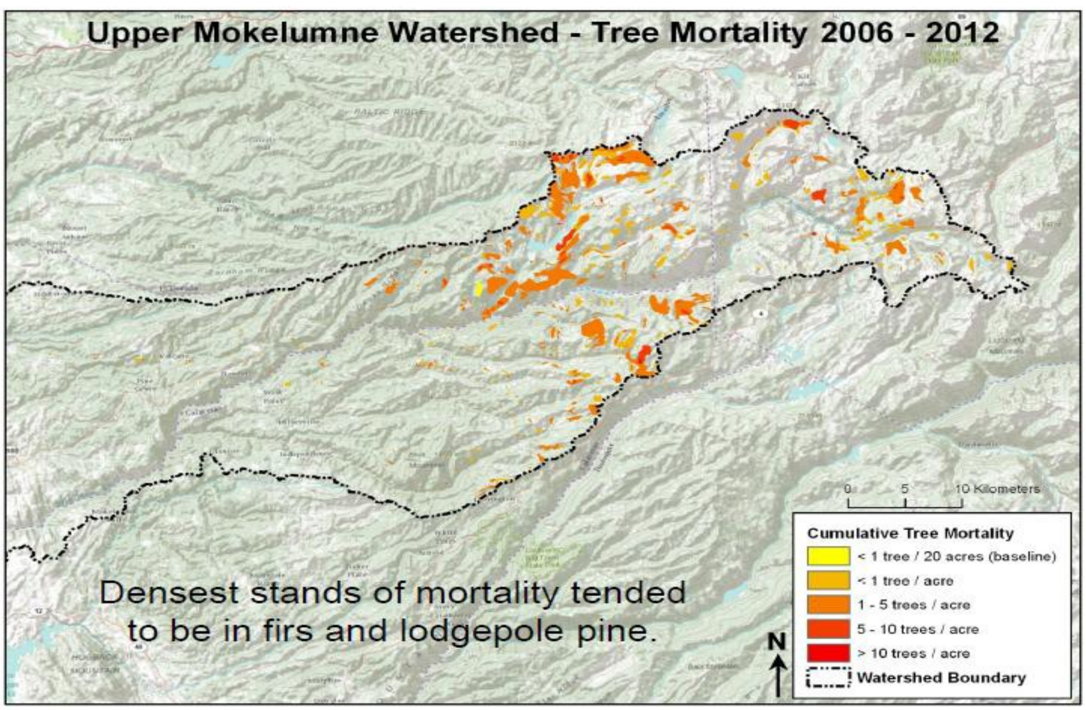
[1] http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696
http://caforestpestcouncil.org/meetings-reports/

Table B.1: Number of acres with tree mortality primarily caused by bark beetles in the Mokelumne watershed

Host Species	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*Totals*
Lodgepole Pine	732	2,753	231	1,874	472	1,248	1,176	*8,487*
White Fir	27		16	2,529	2,910	829	8	*6,319*
Mixed Conifer	4,893	73	228		924			*6,118*
Firs	554	502	105	434	1,843	997		*4,434*
Pines	11	3,425	15	283	32	125		*3,892*
California Red Fir	1,051		73	1,435	308	248	12	*3,127*
Ponderosa Pine	57	7	365	322	431	246	155	*1,583*
Western White Pine	3		1	268		21	90	*383*
Jeffrey Pine	125	2	45		91	8	36	*307*
Sugar Pine	6		5	13	1	52	41	*119*
Whitebark Pine	2		2	2	2		4	*13*
Totals	*7,461*	*6,762*	*1,086*	*7,160*	*7,014*	*3,775*	*1,523*	*34,781*

Source: Forest Health Protection, Aerial Detection Survey program.

Figure B.1: Cumulative tree mortality primarily caused by bark beetles in the Mokelumne



Source: Forest Health Protection, Aerial Detection Survey program.

Heterobasidion root disease (*Heterobasidion* sp.) is one of the most important conifer diseases in the Sierra Nevada and likewise in the Mokelumne watershed. This root disease, in combination with the fir engraver beetle, has contributed to high levels of white fir mortality in the watershed. In recreation areas, Heterobasidion root disease-infected trees can be extremely hazardous, causing death or injury to visitors, and damage to property when they fail. Ecologically, this root disease decays wood in the butt and roots of trees and recycles nutrients. It can create stand openings and alter forest structure, composition, and succession, thus providing enhanced diversity and improved wildlife habitat for certain species.

Dwarf mistletoes (*Arceuthobium* spp.) are considered widespread in the Sierra Nevada range and occur in the Mokelumne watershed. They can be a major cause of growth loss and a reduction in vigor, with the degree of growth reduction dependent upon the intensity of infection and the location of the mistletoe in the tree. Dwarf mistletoes can kill trees directly, but it is more common to find heavily infected trees attacked and killed by bark beetles and/or woodborers.

White pine blister rust (*Cronartium ribicola)* has been devastating to sugar pine since the disease entered northern California around 1930. Although the spread of blister rust in the Sierra Nevada range has been slow and erratic, infections have been reported over the entire range of sugar pine, except for in a few isolated areas. All age and size classes of sugar pines are highly vulnerable to the disease, which can eventually result in branch kill, whole tree mortality or infestation by mountain pine beetle. This rust has also been found on western white pine (*P. monticola*) and whitebark pine (*P. albicaulis*) in the upper reaches of the watershed.

Table B.2: Key forest health indicators and agents

Indicator	*Agents*	*Measures*	*Source*
Acres, %, or number of trees affected by native insects and diseases	bark/engraver beetles; root diseases	Number of dead trees; % infected trees	Aerial surveys; ground surveys; FHP evaluations; CAIDA; FIA data; pertinent literature and reports.
Acres, %, or number of trees affected by abiotic processes (non-fire)	Weather related; ozone		Aerial surveys; ground surveys; FHP evaluations; CAIDA; FIA data; pertinent literature and reports.
Acres, %, or number of trees affected by invasive insects and diseases	White pine blister rust	% infected trees	Aerial surveys; ground surveys; FHP evaluations; CAIDA: FIA data; pertinent literature and reports.
Acres susceptible to native insects and diseases (overall risk, % host BA loss, % total BA loss)	bark/engraver beetles *Heterobasidion* sp.	Total SDI, % host, host, QMD, drought frequency Annual temp., annual precip., soil moisture regime, host QMD, % host, host BA, total BA; annual relative humidity	NIDRM, pertinent literature and reports.

FHP: Forest Health Protection; CAIDA: California insect and disease atlas; NIDRM, National insect and disease risk map; FIA, Forest Inventory and Analysis; SDI, Stand density index; QMD, quadratic mean diameter; BA, basal area

B.2 Bark Beetles

Native bark beetles are a major cause of tree mortality in the Mokelumne watershed. When, where, and the extent to which they cause tree mortality is typically influenced by forest stand conditions and weather patterns. A dramatic increase in the number of dead trees follows one to several years of inadequate precipitation. The more severe and prolonged the drought, the greater the number of dead trees. Dense stands are particularly susceptible to bark beetle attacks due to stress caused by increased competition for limited resources. Stressed trees are suitable host material for bark beetles; their successful colonization results in increased beetle populations and higher levels of tree mortality. Bark and engraver beetle-caused mortality in pine types occurs primarily as small groups of trees, whereas fir mortality caused by the fir engraver beetle can occur as single trees scattered over several hundred acres. Successful attacks by pine bark beetles almost always result in tree mortality. Successful attacks by the fir engraver can result in top-kill, branch kill, or whole tree mortality. In general, bark beetle-caused tree mortality occurs in stands with high tree density, however during periods of protracted drought, mortality may be expected to occur in less dense stands as well.

Bark beetles spend most of their lives beneath the bark of their host and are only exposed to outside environments when they mature and disperse to find new hosts. For most conifer species, there is at least one bark beetle that is capable of killing the tree under the right conditions. Bark beetles are fairly opportunistic and usually require their hosts to be under some form of physiological stress for colonization to be successful. Some of the typical agents of stress, in addition to drought, include defoliating insects, various tree diseases, and a number of abiotic agents (air pollution, fire, wind damage, mechanical injury, etc.). Populations of bark beetles can fluctuate dramatically from year to year depending on the degree to which stress agents are operating in the forest. Available food source (i.e. the availability of stressed trees) is the ultimate regulator of bark beetle populations.

B.3 Root Diseases

Root diseases are important natural disturbance agents in the Mokelumne watershed. Root disease organisms kill host cambium, decay wood, plug water conducting tissue, or cause some combination of these effects. Tree death resulting from root disease can occur when trees die outright, when those with decayed roots are wind thrown, or when bark beetles attack weakened trees. Some root pathogens are favored by conditions associated with low host vigor, others are able to cause infection regardless of tree condition. Some are quite host specific, while others can infect multiple hosts. Susceptibility to root disease pathogens also varies with host age and/or geographic location.

Root diseases exert profound influences on forest structure, composition, function, and yield. Root diseases are important gap formers, creating openings in the forest of varied sizes, depending upon the pathogen(s) and hosts present. They also influence tree species composition by selectively killing some species while not affecting others. Stocking levels may be reduced in discrete areas or across stands depending on the distribution of inoculum and the tree species present. Species diversity may increase or decrease depending upon location. Root diseases influence structure by reducing the likelihood that some trees will achieve large sizes, or by slowing the process. Root diseases kill trees creating snags and down woody material that are important for wildlife habitat, and also create down woody material that is important for soil water holding capacity and nutrient cycling. This material can also contribute to fuels accumulation.

Heterobasidion sp. infect a wide range of woody plants. Trees suffering from root rot are markedly less able to absorb and translocate sufficient water. During periods of drought, trees with decayed roots are more likely to die, usually as a result of bark beetle attacks. Affected trees are also more vulnerable to wind throw. In true firs, the fungus causes root and butt decay more often than mortality, at least in larger trees. This may result in wind throw and increased susceptibility to engraver beetle attack. Potential impacts of the disease include increased susceptibility of infected trees to attack by bark beetles, tree mortality, and the loss of site productivity. In recreation areas root diseases can result in the depletion of vegetative cover, loss of aesthetic views, and raise great concern regarding tree failure. Heterobasidion-infected trees can be extremely hazardous, causing death or injury, and damage to property when they fail.

B.4 Mistletoes

Parasitic flowering plants commonly known as mistletoes are found in the Mokelumne watershed. Two genera of mistletoes are native: *Phoradendron* (true mistletoes) and *Arceuthobium* (dwarf mistletoes). The true mistletoes grow on both conifers and broadleaf trees; the dwarf mistletoes grow only on conifers. Although both mistletoes are damaging parasites of trees, by far the greatest timber loss in coniferous forests is attributed to dwarf mistletoes. They also cause serious damage to trees in high-value, high-use forest recreational areas.

B.5 Abiotic Agents

Drought can be a local problem when plants are growing in soil with a low moisture holding capacity, or can be more widespread when insufficient precipitation occurs. Reduced moisture availability increases the susceptibility of plants to injury and mortality caused by insects and diseases. Ozone damage is especially likely to occur in forests located near some of the passes and on the west side of the Sierra Nevada range, due to polluted air from areas with high vehicular traffic. Ozone affected trees are less vigorous and are more easily affected by diseases and bark beetles. The application of de-icing salt along roads can lead to needle tip dieback of conifers. Symptoms are usually evident within 100 feet of the road on the down slope side, although this distance may increase along drainages. Most herbicide injury is a result of improper application. Injury is usually found along roads, rights of way, fuel breaks, dwellings, or other areas where herbicides are improperly applied.

Fire can outright kill trees, cause injuries that result in eventual mortality, or can cause injured trees to be more susceptible to bark beetles and woodborers, thus also resulting in tree mortality. A fire-injured trees susceptibility to bark beetles is determined by the amount of injury and the tree's response, the time of year fire occurs, populations of bark beetles within the vicinity, and pre- and post-fire weather patterns (Gibson and Negron 2007). In addition, bark beetle-caused tree mortality may result in changes to fuels complexes and fire behavior during and following beetle outbreaks.

Severe winter storms cause tree injury in the forms of windthrow, breakage, or stem deformations from snow loading. Green slash or injured live trees can be highly attractive to engraver and bark beetles.

B.6 Invasive Diseases

The most damaging conifer rust in California, white pine blister rust (WPBR), was introduced to the west coast of North America in 1910 and continues to pose a serious threat to regeneration and management of sugar pine in California. Because of its impacts on ecosystem diversity, it is also becoming a concern in high elevation white pines. WPBR infects needles of the five-needle white pines and spreads into branches and sometimes into the main stem. WPBR can infect even the healthiest of trees. For some trees, infection only means a slowing of the growth rate; for many others, however, infection leads to a protracted death. This disease readily kills seedlings and also can result in reduced cone production, thus negatively affecting regeneration.

B.7 Interactions of Insects, Diseases, and Abiotic Agents

Frequently, more than one causal factor contributes to tree mortality, and certain sets of factors are commonly found in association with one another. Phytophagous (plant eating) insects and tree pathogens are often close associates in forests and, usually a forest stand will be influenced by a number of different diseases and insects concurrently. One organism may affect a tree and weaken it, predisposing it to attack by another, or one organism may actually introduce another organism into the host. In addition, abiotic factors frequently function as stressors, predisposing trees to mortality caused by biotic agents.

A pattern of decreasing precipitation or changes in precipitation patterns may reduce the growth & vigor of vegetation, thereby increasing the susceptibility to mortality caused by insects and diseases. There is abundant evidence that bark beetle caused tree mortality dramatically increases in the Sierra Nevada during extreme or protracted drought periods[2]. If droughts become more frequent, of greater intensity, or are more protracted in the future, high levels of bark beetle-caused tree mortality should be expected. In addition, bark beetle population success is influenced directly by temperature effects on insect development (Powell and Logan 2005). Some bark beetle species may be able to complete additional generations in a year and timing of beetle emergence and flight periods may be altered. Stand density and host species composition are also important factors in determining drought effects. Although all stands become increasingly stressed as drought persists, tree mortality is typically higher in denser stands. Those species less tolerant of drought are likely to be attacked by bark beetles first, followed by attacks to more drought tolerant species.

Most plant pathogens are strongly influenced by environmental conditions and vigor of the host (Kliejunas et al. 2009). Climate change will directly affect the pathogen, the host, and the interaction between them, resulting in disease impacts (Brasier 2005, Burdon et al. 2006). Root pathogens such as *Heterobasidion* sp. are more aggressive when hosts are stressed, so its incidence

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[2] http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696
http://caforestpestcouncil.org/meetings-reports/

and spread could increase (Kliejunas et al. 2009) under future climate regimes. Mistletoes currently play a significant role in tree mortality when trees are stressed by drought and other agents. Surveys in California indicated that trees infected with dwarf mistletoe were the first to die during drought (Byler 1978). If droughts become more frequent, of greater intensity, or are more protracted in the future, mistletoes will continue to cause mortality, be a predisposing factor to attack by bark beetles, and may also expand their range (Kliejunas et al. 2009). Although stem rusts (*Cronartium* sp.) can adapt to a wide range of environmental conditions, their tolerances are unknown. Under changing climates, the incidence of rusts will be determined chiefly by host distribution. Typically, rusts increase in intensity and distribution in “wave years” during which the weather is especially favorable for sporulation, dispersal, and infection. As climate changes, the frequency of such waves years is expected to change (Kliejunas et al. 2009).

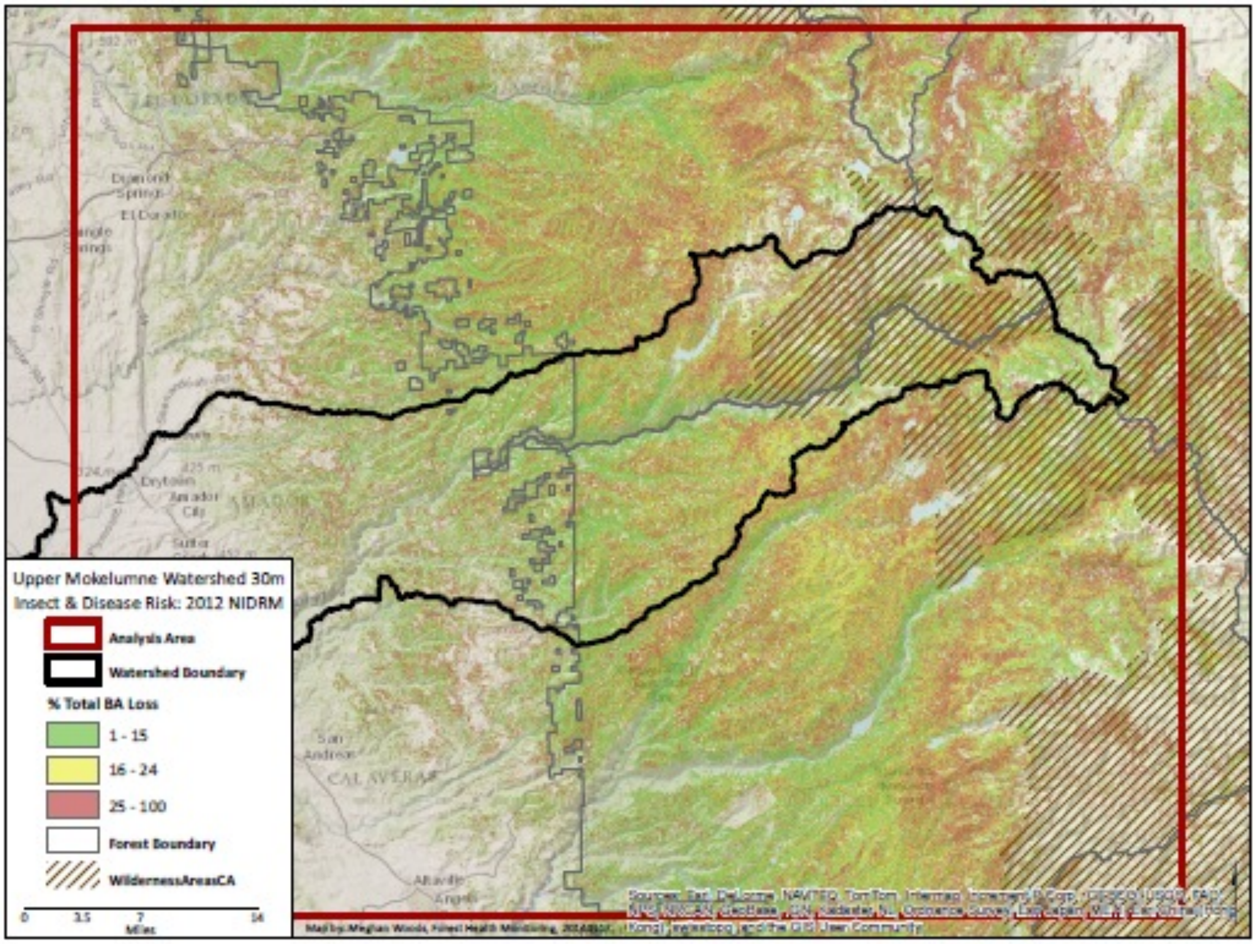
Interactions between bark beetles and fire are complex. In the long run, reintroducing fire to fire-adapted forest ecosystems will favor species and plant communities that are better adapted to these ecosystems. In the short term fire can damage residual trees to the extent that they become more susceptible to bark beetle attacks and in some cases can lead to increased bark beetle activity for one to two seasons following the fire. Areas that have already experienced bark beetle outbreaks may have altered fuel loads (and hence, potential for changes to subsequent fire behavior) for many years afterward. The specific local effects depend on a variety of factors including the number of dead trees, stand structure and species composition, aspect, and time since outbreak (Hicke et al. 2012).

B.8 Susceptibility to Future Tree Mortality caused by Insects and Diseases

Susceptibility of forests in the Mokelumne watershed to future tree mortality caused by insects and diseases was assessed nationally in 2012 resulting in the National Insect and Disease Risk Map (NIDRM)[3]. The 2012 NIDRM was driven by several models used to predict how individual tree species would react to various mortality agents. The models were developed using the interactions of predicted agent behavior and known forest parameters. The most widely used forest parameters for the NIDRM were stand basal area, stand density index, and quadratic mean tree diameter. Risk of mortality is defined as “the expectation that 25% or more of the standing live volume greater than 1” diameter at breast height will die over the next 15 years. Output for the national risk map was generated at 30m resolution. In the Mokelumne analysis area (area within the red triangle box in Figure B.2) 1,355 hectares were determined to be susceptible to high levels ($\geq$25% of the standing volume) of insect and disease-caused mortality over the next 15 years based on the 2012 NIDRM (Figure B.2). Within the watershed boundary area (within the black outlined polygon in Figure B.2) 254 hectares are susceptible to high levels of tree mortality. A 30m version of the risk map, utilizing the same models and methodology as the 240m map, will be available for future consideration.

[3] http://www.fs.fed.us/foresthealth/technology/nidrm.shtml

Figure B.2: Mokelumne watershed percent total basal area loss over the next 15 years due primarily to bark beetles



B.9 Issues and Opportunities

Acres determined to be susceptible to mortality should be surveyed for opportunities for treatment, primarily thinning to reduce stand density, if they occur where higher levels of mortality will affect the ability to meet land management objectives and goals. In general, higher levels of tree mortality may be acceptable on general forest land and in remote or wilderness areas, whereas preventing tree mortality would be preferred in campgrounds, around homes, structures, utility lines, evacuation corridors, and in areas highly susceptible to wildfire. Depending on the stand structure and density, treatments designed to meet fuels treatments alone may not reduce susceptibility to bark beetle-caused mortality. An integrated approach to determining treatment areas, residual tree density, and residual species composition will allow for strategic placement of treatment areas and afford the ability to meet multiple resource objectives with one entry.

It is important to consider the current and potential future effects from several agents of change when designing treatments aimed at reducing wildfire risks. Failure to reduce forest susceptibility to insects and diseases can lead to large-scale tree mortality that may affect forest management objectives, alter fire behavior, or require additional costly fuel reduction measures. In some situations, fuel reduction thinning can actually increase the impacts from insects and diseases, by providing slash or stumps for insect or pathogen buildup. In all cases, treatments are more likely to be cost-effective and accomplish broader, long-term forest health goals when multiple agents of change are considered prior to project implementation.

The necessity of reducing wildfire risks in urban interface areas demands comprehensive design solutions, guided by the over-arching goal of improving forest health conditions.

Responding to the threats and damage from wildfire will require a variety of treatment tools to assure long-term success and to meet broader objectives of restoring and maintaining forest ecosystem health. The consideration of insects and diseases in the planning process will help assure that success.

In many cases, insect or disease management objectives can be met by modifying the fuel treatment design. Insect and disease treatment needs vary by location, tree species, and management objectives—one treatment does not fit all.

B.9.1 Bark Beetles

Situation: Bark beetles are one of the most significant agents causing conifer mortality in western forests. Typically with many "fuels" reduction projects not enough stems (either number of stems and/or size of trees) are removed to lower residual basal area to a condition that would be much less susceptible to bark beetle attack.

Options: Thinning can reduce susceptibility to bark beetles; however, it may be necessary to thin stands to lower densities than might be adequate for fuel reduction purposes alone. Residual basal area or SDI targets that are less susceptible to bark beetle attack are known (NIDRM 2012).

Situation: Pine engraver beetles breed in fresh pine debris including thinning slash. At times, frequently during droughts, these insects attack residual trees or trees in adjacent un-thinned areas.

Options: Pine engraver beetle attacks in living trees can be reduced through greater wood utilization, slash treatment, and/or by avoiding slash creation during high hazard months.

Situation: Interactions between bark beetles and fire are complex. Reintroducing fire to fire-adapted western forest ecosystems will favor species and plant communities that are better adapted to these ecosystems. However, fire can damage residual trees to the extent that they become more susceptible to bark beetle attacks and in some cases can lead to increased bark beetle activity for one to two seasons following the fire.

Options: Include Forest Health Protection personnel when determining the likely level of post-prescribed fire mortality. Deep duff layers, around trees that are important to keep alive post-fire, should be removed prior to burning.

B.9.2 Root Diseases and Stem Decays

Root diseases and stem decays are caused by various fungal pathogens that kill or decay roots or the stem of their primary hosts, often leading to tree death. Tree thinning or fire can increase disease-caused tree mortality or cause extensive stem decay, the extent of which may not be realized for many years in the future. Once root disease becomes established in a susceptible stand, tree mortality can persist for the life of the stand and into the next rotation. Continuing tree mortality can lead to large openings in the stand or even death of most trees in the stand within one to several decades.

The goal of Heterobasidion root disease management is to reduce resource losses to levels which are economically, aesthetically, and environmentally acceptable dependent upon land management goals and objectives. Impacts of Herterobasdion root disease can be reduced through detection, evaluation, prevention, and suppression. These activities must progress in a planned, timely sequence for successful reduction of impacts. In developed recreation sites, early recognition and removal of hazardous trees is critical, and will greatly improve chances of preventing future damage with minimal site deterioration. Prevention is the most desirable means of reducing losses. Any tree can fall at any time, external and internal indicator improve our ability to make some educated guesses on which trees are more susceptible to failure so the risk can be lowered, either by removing the target or removing the tree.

Situation: Heterobasidion root disease becomes established by invading stumps following cutting, then can persist and kill trees for decades.

Options: Infection can be prevented by treating freshly cut stumps with a borate compound.

Situation: Wood decay fungi can rot the wood of living trees following fire scaring, logging injury or other means.

Options: Injury can be prevented or reduced by avoiding bole injuries to residual trees when thinning or burning, favoring decay-resistant species, or removing decayed or damaged trees in subsequent thinning.

B.9.3 Dwarf Mistletoes

There are a variety of silvicultural options that can be used to control undesirable effects of dwarf mistletoe. Many of these can be incorporated when entering stands to thin or do other management activities. Infestations of dwarf mistletoe not only affect timber values but also recreation, aesthetics, fire hazard, and wildlife habitat. In addition, mistletoe brooms can be hazardous if there is a target and they break and fall on something or someone. Mistletoe-infected trees can also be more susceptible to bark beetle attacks, particularly during low water years. Since the impacts of dwarf mistletoe are, in most cases, not significant until trees are heavily infected, the key to successfully avoiding serious effects of mistletoe on tree growth and survival, as well as associated effects on stand structure, is to prevent heavy infection.

Situation: Dwarf mistletoes are parasitic plants that infect the branches and stems of many conifers. Heavy infections can reduce tree growth and lead to premature death. In addition, the brooms formed by infected trees are highly flammable. Dwarf mistletoes are difficult to eliminate from stands and complete removal may not be desirable due to the wildlife values associated with brooms.

Options: The effects from dwarf mistletoe can be reduced during thinning by favoring non-hosts or lightly infected individuals. The probability of crown fire can be reduced by removing smaller infected trees and by pruning brooms from the lower crowns of larger trees. Pruning of large brooms can also lengthen the life of individual trees.

B.9.4 Urban Interface Forest Health Treatments

Situation: Treatments to lower the wildfire, insect and disease susceptibility of stands near communities is necessary to make them defensible from wildfires and to restore and maintain long-term tree health.

Options: With proper design, projects done primarily to reduce fuels can contribute to broader objectives. Through cooperative projects we have the opportunity to reduce fuels and address insect and disease issues in an integrated manner among multiple ownerships across the landscape.

Situation: Communities value a variety of management objectives, which can have conflicting vegetation treatment designs.

Options: It may be feasible to use a variety of treatments to result in a mosaic of stand conditions to meet a variety of objectives: to restore and maintain fire-adapted trees species; to achieve a mix of stand age classes, densities and openings; and better provide for wildlife habitat, watershed protection and visual beauty.

All of these aspects should be addressed by forest management specialists on a site-specific basis.

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Mokelumne Watershed Avoided Cost Analysis: Why Sierra Fuel Treatments Make Economic Sense

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Disclaimer

This report is rich in data and analyses and may help support planning processes in the watershed. The data and analyses were primarily funded with public resources and are therefore available for others to use with appropriate referencing of the sources. This analysis is not intended to be a planning document.

The report includes a section on cultural heritage to acknowledge the inherent value of these resources, while also recognizing the difficulty of placing a monetary value on them. This work honors the value of Native American cultural or sacred sites, or disassociated collected or archived artifacts. This work does not intend to cause direct or indirect disturbance to any cultural resources.

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